

SOLAR OBSERVATIONS

SOLAR AND SKY RADIATION MEASUREMENTS DURING
APRIL, 1930

By HERBERT H. KIMBALL, Solar Radiation Investigations

For reference to descriptions of instruments and exposures, and an account of the method of obtaining and reducing the measurements, the reader is referred to this volume of the REVIEW, page 26.

Table 1 shows that solar radiation intensities averaged slightly below the normal intensity for April at all three stations.

Table 2 for March shows an excess in the total radiation received on a horizontal surface at Washington, Madison, Lincoln, Chicago, and Twin Falls, and a deficiency at Fresno and La Jolla. For April there was a slight deficiency recorded at Washington, Lincoln, and La Jolla, and an excess at Madison, Chicago, and Twin Falls.

TABLE 1.—Solar radiation intensities during April, 1930

(Gram-calories per minute per square centimeter of normal surface)

| Washington, D. C. | | | | | | | | | | | | | |
|-------------------|-----------------------|------------|-------------|-------------|-------------|-------------|-------------|-------------|-------------|-------------|-------------|--------------------------------|------------|
| Date | Sun's zenith distance | | | | | | | | | | | | |
| | 8 a.m. | 78.7° | 75.7° | 70.7° | 60.0° | 0.0° | 60.0° | 70.7° | 75.7° | 78.7° | Noon | | |
| | 75th mer. time | Air mass | | | | | | | | | | Local mean solar time | |
| | | A. M. | | | | | P. M. | | | | | | |
| | | e. | 5.0 | 4.0 | 3.0 | 2.0 | 1.0 | 2.0 | 3.0 | 4.0 | 5.0 | | e. |
| | | <i>mm.</i> | <i>cal.</i> | <i>cal.</i> | <i>cal.</i> | <i>cal.</i> | <i>cal.</i> | <i>cal.</i> | <i>cal.</i> | <i>cal.</i> | <i>cal.</i> | | <i>mm.</i> |
| Apr. 2 | 3.81 | | 0.81 | 1.00 | 1.10 | | | | | | 2.74 | | |
| Apr. 4 | 5.36 | | 0.53 | 0.73 | 1.07 | | 1.13 | 0.86 | 0.61 | | 4.37 | | |
| Apr. 5 | 3.15 | | 0.71 | 0.89 | 1.11 | | | | | | 4.75 | | |
| Apr. 7 | 5.56 | | 0.84 | 1.00 | 1.18 | | | | | | 6.76 | | |
| Apr. 9 | 2.16 | | 1.05 | 1.16 | 1.28 | 1.48 | 1.10 | 0.77 | | | 1.78 | | |
| Apr. 10 | 3.99 | 0.47 | 0.62 | 0.75 | | 1.35 | | | | | 2.74 | | |
| Apr. 15 | 6.50 | | | 0.54 | | | | | | | 4.95 | | |
| Apr. 22 | 7.87 | | | | 0.97 | | | | | | 7.04 | | |
| Apr. 24 | 2.62 | | | | 1.10 | 1.43 | 0.90 | 0.60 | | | 2.62 | | |
| Apr. 25 | 3.81 | | | 0.84 | 1.07 | 1.46 | | | | | 4.17 | | |
| Apr. 26 | 6.27 | | | 0.59 | 0.83 | 1.27 | | | | | 4.37 | | |
| Apr. 29 | 8.18 | | | | | 1.04 | 0.76 | | | | 4.95 | | |
| Means | | (0.47) | 0.76 | 0.83 | 1.08 | 1.34 | 0.97 | 0.74 | (0.61) | | | | |
| Departures | | -0.23 | ±0.00 | -0.06 | ±0.00 | -0.02 | -0.12 | -0.10 | -0.13 | | | | |

Madison, Wis.

| | | | | | | | | | | |
|-----------------|------|--|-------|-------|-------|-------|-------|--|--|------|
| Apr. 1..... | 2.87 | | | | | 1.15 | | | | 2.62 |
| Apr. 2..... | 3.00 | | 0.82 | 0.96 | | 1.17 | | | | 2.62 |
| Apr. 3..... | 3.99 | | 1.01 | | | 1.27 | | | | 4.17 |
| Apr. 4..... | 3.81 | | 0.72 | 0.81 | 1.12 | 1.42 | 0.96 | | | 4.57 |
| Apr. 7..... | 3.45 | | 0.98 | 1.11 | 1.26 | | 1.19 | | | 2.26 |
| Apr. 8..... | 2.36 | | | 1.22 | 1.33 | 1.54 | 1.23 | | | 1.96 |
| Apr. 9..... | 2.62 | | | 0.85 | 1.05 | | | | | 3.45 |
| Apr. 14..... | 4.75 | | | 0.77 | 1.03 | 1.38 | | | | 4.57 |
| Apr. 19..... | 2.87 | | | 0.96 | 1.19 | 1.45 | | | | 2.26 |
| Apr. 22..... | 2.74 | | | 1.06 | 1.22 | 1.47 | | | | 2.36 |
| Apr. 23..... | 1.96 | | | 1.03 | 1.21 | | | | | 2.36 |
| Apr. 24..... | 2.26 | | | 1.02 | 1.20 | 1.47 | | | | 3.00 |
| Apr. 25..... | 3.63 | | | 0.93 | 1.09 | | 0.89 | | | 3.15 |
| Apr. 26..... | 4.17 | | | 0.82 | 1.08 | 1.35 | | | | 3.81 |
| Means..... | | | 0.88 | 0.96 | 1.16 | 1.45 | 1.12 | | | |
| Departures..... | | | -0.08 | -0.09 | -0.05 | -0.02 | -0.09 | | | |

Lincoln, Nebr.

| | | | | | | | | | | |
|-----------------|------|--|--------|-------|-------|--------|-------|-------|--------|--------|
| Apr. 1..... | 3.00 | | | 0.87 | 1.24 | | | | | 3.63 |
| Apr. 2..... | 3.45 | | | | 1.15 | | 1.05 | 0.78 | | 5.79 |
| Apr. 3..... | 3.99 | | | 1.06 | 1.21 | | 1.06 | 0.93 | 0.79 | 7.04 |
| Apr. 6..... | 3.45 | | | | | | 1.22 | 1.06 | 0.90 | 4.75 |
| Apr. 7..... | 2.26 | | 1.09 | 1.19 | 1.36 | 1.49 | | | | 3.30 |
| Apr. 22..... | 4.57 | | | | 1.19 | | | | | 2.30 |
| Apr. 24..... | 4.17 | | 0.68 | 0.87 | 1.07 | | | | | 4.37 |
| Means..... | | | (0.88) | 1.00 | 1.20 | (1.49) | 1.11 | 0.92 | (0.84) | (0.75) |
| Departures..... | | | +0.04 | +0.02 | -0.01 | | -0.06 | -0.06 | -0.01 | +0.03 |

1 Extrapolated.

Skylight polarization measurements obtained on eight days at Washington give a mean of 46 per cent and a maximum of 60 per cent on the 9th. These are slightly below the corresponding averages for April at Washington. At Madison measurements obtained on 11 days give a mean of 58 per cent with a maximum of 70 per cent on the 8th. These are close to the corresponding averages for April at Madison.

TABLE 2.—Total solar radiation (direct+diffuse) received on a horizontal surface

(Gram calories per square centimeter)

| Week beginning | Average daily totals | | | | | | | | | |
|--|--------------------------------|---------|---------|---------|----------|------------|-------------|------------|--------|----------|
| | Washington | Madison | Lincoln | Chicago | New York | Pittsburgh | Gainesville | Twin Falls | Fresno | La Jolla |
| 1930 | | | | | | | | | | |
| Apr. 2..... | 339 | 518 | 550 | 393 | --- | 285 | 525 | 423 | 560 | 421 |
| Apr. 9..... | 455 | 341 | 430 | 409 | --- | 332 | 548 | 380 | 569 | 411 |
| Apr. 16..... | 327 | 296 | 333 | 240 | --- | 269 | 519 | 561 | 614 | 475 |
| Apr. 23..... | 478 | 475 | 281 | 407 | --- | 276 | 605 | 491 | 576 | 466 |
| | Departures from weekly normals | | | | | | | | | |
| Apr. 2..... | -48 | +134 | +124 | +106 | --- | --- | --- | +39 | +32 | -7 |
| Apr. 9..... | +56 | -60 | +14 | +97 | --- | --- | --- | -44 | +3 | -32 |
| Apr. 16..... | -87 | -103 | -98 | -68 | --- | --- | --- | +96 | +20 | +22 |
| Apr. 23..... | +56 | +45 | -199 | +86 | --- | --- | --- | -41 | -56 | -10 |
| accumulated departures on Apr. 29..... | -371 | -112 | -490 | +2,289 | --- | --- | --- | +2,261 | -799 | -2,401 |

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| | | | | | | | | | | |
|--------------------------------------|------|------|------|------|-----|-----|--------|------|--------|--|
| Feb. 26..... | 290 | 299 | 405 | 210 | 150 | 420 | 284 | 266 | 329 | |
| Mar. 5..... | 200 | 309 | 390 | 220 | 236 | 367 | 314 | 400 | 339 | |
| Mar. 12..... | 309 | 336 | 351 | 220 | 265 | 253 | 300 | 382 | 296 | |
| Mar. 19..... | 398 | 283 | 360 | 225 | 292 | 476 | 419 | 511 | 402 | |
| Mar. 26..... | 386 | 424 | 504 | 223 | 254 | 483 | 447 | 491 | 378 | |
| Feb. 26..... | +3 | +12 | +56 | +17 | | | +27 | -80 | -25 | |
| Mar. 5..... | -56 | +14 | +26 | +22 | | | +34 | +35 | +4 | |
| Mar. 12..... | +41 | +13 | -21 | +10 | | | -10 | -28 | -40 | |
| Mar. 19..... | +38 | -42 | -43 | +4 | | | +87 | +39 | +28 | |
| Mar. 26..... | +33 | +57 | +94 | -15 | | | +102 | -24 | -29 | |
| accumulated departure on Apr. 1..... | -210 | -224 | +623 | +742 | | | +1,911 | -792 | -2,112 | |

POSITIONS AND AREAS OF SUN SPOTS

[Communicated by Capt. V. K. Coman, Acting Superintendent U. S. Naval Observatory. Data furnished by Naval Observatory, in cooperation with Harvard, Yerkes, Perkins, and Mount Wilson Observatories. The differences of longitude are measured from central meridian, positive west. The north latitudes are plus. Areas are corrected for foreshortening and are expressed in millionths of sun's visible hemisphere. The total area, including spots and groups, is given for each day in the last column]

| Date | Eastern standard civil time | Heliographic | | | Area | | Total area for each day |
|-----------------------------|-----------------------------|---|---|--|------|-----------------------------|-------------------------|
| | | Diff. long. | Longitude | Latitude | Spot | Group | |
| 1930 | | | | | | | |
| Apr. 1 (Naval Observatory). | h m 11 43 | ° -79.5 -28.0 -4.0 +37.0 +37.0 | ° 307.3 358.8 22.8 63.8 63.8 | ° +14.0 -13.0 -5.5 +8.5 -16.0 | 6 | 278 | |
| Apr. 2 (Naval Observatory). | 10 58 | -68.5 +10.5 +52.0 +65.0 | 305.5 24.5 66.0 79.0 | +12.5 -5.0 +7.5 +8.0 | | 617 401 77 93 | |
| Apr. 3 (Mount Wilson). | 13 0 | -56.0 -9.0 +26.0 +69.0 +76.0 | 303.6 350.6 25.6 68.6 75.6 | +13.0 -20.0 -5.0 +9.0 +7.0 | | 435 2 467 61 10 | |
| Apr. 4 (Naval Observatory). | 11 5 | -42.5 +40.0 | 305.0 27.5 | +12.5 -5.5 | 309 | 494 | |
| Apr. 5 (Naval Observatory). | 11 13 | -76.0 -69.5 -28.5 +54.0 | 258.2 264.7 305.7 28.2 | +15.5 -6.5 +13.0 -5.0 | 31 | 540 | |
| | | | | | 278 | | 877 |

Positions and areas of sun spots—Continued

| Date | Eastern standard civil time | Heliographic | | | Area | | Total area for each day |
|-------------------------------|-----------------------------|--------------|------------|----------|------|-------|-------------------------|
| | | Diff. long. | Longi-tude | Latitude | Spot | Group | |
| Apr. 6 (Mount Wilson) | h m 18 15 | ° | ° | ° | | | |
| | | -60.0 | 257.2 | +16.0 | | 13 | |
| | | -53.0 | 264.2 | -7.0 | | 11 | |
| | | -29.0 | 288.2 | +9.0 | 8 | | |
| | | -7.0 | 310.2 | +13.0 | | 529 | |
| Apr. 7 (Naval Observatory) | 10 41 | +69.0 | 28.2 | -5.0 | 346 | | 907 |
| | | -49.5 | 258.6 | +15.0 | | 62 | |
| | | -41.5 | 266.6 | -7.0 | | 31 | |
| | | -19.0 | 289.1 | +8.0 | 6 | | |
| | | -0.5 | 307.6 | +13.0 | | 448 | |
| Apr. 8 (Naval Observatory) | 11 38 | +80.5 | 28.6 | -5.0 | 185 | | 732 |
| | | -61.5 | 232.9 | -7.5 | | 19 | |
| | | -37.0 | 257.4 | +15.0 | 123 | | |
| Apr. 9 (Naval Observatory) | 10 53 | +13.5 | 307.9 | +12.5 | 401 | | 543 |
| | | -62.0 | 219.6 | +14.0 | | 19 | |
| | | -47.5 | 234.1 | -8.0 | | 31 | |
| | | -41.0 | 240.6 | +12.0 | 9 | | |
| | | -20.5 | 261.1 | +15.0 | 25 | | |
| Apr. 10 (Naval Observatory) | 11 7 | +29.5 | 311.1 | +12.0 | 355 | | 439 |
| | | -49.0 | 219.3 | +14.0 | | 123 | |
| | | -35.0 | 233.3 | -7.0 | | 9 | |
| | | -8.0 | 260.3 | -11.5 | 3 | | |
| | | -6.5 | 261.8 | +15.0 | 12 | | |
| Apr. 11 (Naval Observatory) | 11 2 | +23.5 | 291.8 | +8.0 | 19 | | |
| | | +42.0 | 310.3 | +12.0 | 355 | | 521 |
| | | -38.0 | 217.2 | +13.5 | | 185 | |
| | | -20.5 | 234.7 | -7.0 | | 62 | |
| | | +6.0 | 261.2 | +15.0 | 6 | | |
| Apr. 12 (Naval Observatory) | 11 27 | +55.0 | 310.2 | +12.0 | 340 | | 593 |
| | | -25.0 | 216.7 | +14.0 | | 185 | |
| | | -7.5 | 234.2 | -7.5 | | 77 | |
| | | +17.0 | 258.7 | +15.0 | | 37 | |
| | | +67.5 | 309.2 | +12.0 | 340 | | 639 |
| Apr. 13 (Naval Observatory) | 11 6 | | | | 6 | | |
| | | -51.5 | 177.2 | +15.5 | | 170 | |
| | | -11.5 | 217.2 | +14.5 | | 93 | |
| | | +4.0 | 232.7 | -8.0 | | 3 | |
| | | +32.0 | 260.7 | +14.5 | 3 | | 642 |
| Apr. 14 (Naval Observatory) | 11 15 | +81.5 | 310.2 | +12.0 | 370 | | |
| | | -38.5 | 176.9 | +15.5 | | 12 | |
| | | +1.5 | 216.9 | +15.0 | | 108 | |
| | | +18.0 | 233.4 | -7.0 | | 93 | |
| | | +69.0 | 284.4 | -11.5 | 22 | | 235 |
| Apr. 15 (Naval Observatory) | 13 10 | | | | 6 | | |
| | | -25.0 | 176.2 | +15.5 | | 22 | |
| | | +17.0 | 218.2 | +14.5 | | 12 | 40 |
| Apr. 16 (Mount Wilson) | 13 15 | +30.0 | 217.9 | +15.0 | | 21 | |
| | | +42.0 | 229.9 | -13.0 | | 65 | |
| | | +55.0 | 242.9 | +12.0 | 9 | | 95 |
| Apr. 17 (Perkins Observatory) | 11 39 | -33.7 | 141.7 | -19.4 | 78 | | |
| | | -22.4 | 153.0 | -20.0 | 31 | | 109 |

Positions and areas of sun spots—Continued

| Date | Eastern standard civil time | | Heliographic | | | Area | | Total area for each day |
|------------------------------------|--------------------------------------|-------|----------------|----------------|----------|------|-------|-------------------------------------|
| | | | Diff. long. | Longi- tude | Latitude | Spot | Group | |
| Apr. 18 (Naval Observa- tory). | h m 12 1 | ° | ° | ° | | | | |
| | | -66.5 | 95.7 | -11.0 | 6 | | | |
| | | -48.0 | 114.2 | +27.5 | | 19 | | |
| | | +56.0 | 218.2 | +15.0 | 9 | | | |
| | | +70.0 | 232.2 | -11.5 | 19 | | | 53 |
| Apr. 19 (Mount Wilson). | 12 0 | -55.0 | 94.0 | -13.0 | | | | |
| | | -40.0 | 109.0 | +28.0 | 16 | | 80 | |
| | | +30.0 | 179.0 | +14.0 | | 9 | | 105 |
| Apr. 19 (Yerkes Observa- tory). | 11 52 | -56.5 | 92.6 | -12.0 | 21 | | | |
| | | -55.5 | 93.6 | -13.5 | 26 | | | |
| | | -51.5 | 97.6 | -13.0 | 64 | | | |
| | | -37.5 | 111.6 | +28.0 | 20 | | | 131 |
| | | | | | | | | |
| Apr. 20 (Naval Observa- tory). | 10 54 | -40.5 | 95.9 | -12.5 | | | 22 | |
| | | -24.0 | 112.4 | +28.0 | | | 77 | |
| | | +43.5 | 179.9 | +15.0 | 9 | | | 108 |
| Apr. 21 (Naval Observa- tory). | 10 51 | -30.0 | 93.2 | -12.0 | | | 19 | |
| | | -10.5 | 112.7 | +27.5 | | | 31 | |
| | | +56.0 | 179.2 | +15.0 | 9 | | | 59 |
| Apr. 22 (Naval Observa- tory). | 11 30 | -89.0 | 20.6 | -6.0 | 170 | | | |
| | | -17.5 | 92.1 | -11.5 | 12 | | | 182 |
| Apr. 23 (Naval Observa- tory). | 11 21 | -76.5 | 20.0 | +12.5 | 9 | | | |
| | | -65.5 | 31.0 | -6.0 | 185 | | | |
| | | -1.0 | 95.5 | -12.0 | 6 | | | |
| | | +60.0 | 156.5 | -6.0 | 6 | | | 206 |
| | | | | | | | | |
| Apr. 24 (Naval Observa- tory). | 11 00 | -61.0 | 22.5 | +13.0 | 15 | | | |
| | | -52.5 | 31.0 | -6.0 | 201 | | | 216 |
| Apr. 25 (Naval Observa- tory). | 10 59 | -47.0 | 23.3 | +12.5 | 9 | | | |
| | | -39.0 | 31.3 | -6.0 | 216 | | | |
| | | +7.5 | 77.8 | +9.0 | 3 | | | |
| | | +30.0 | 100.3 | -12.0 | 2 | | | 230 |
| Apr. 26 (Naval Observa- tory). | 10 54 | -57.0 | 0.1 | -4.0 | 3 | | | |
| | | -35.0 | 22.1 | +13.5 | | | 46 | |
| | | -26.0 | 31.1 | -6.0 | 201 | | | |
| | | +37.5 | 94.6 | +7.5 | 6 | | | |
| | | +42.5 | 99.6 | -12.0 | 6 | | | 262 |
| Apr. 27 (Naval Observa- tory). | 10 6 | -21.5 | 22.8 | +13.5 | | | 62 | |
| | | -13.5 | 30.8 | -6.0 | 216 | | | 278 |
| Apr. 28 (Naval Observa- tory). | 11 33 | -7.5 | 22.8 | +13.5 | | | 77 | |
| | | +1.0 | 31.3 | -6.0 | 231 | | | 308 |
| Apr. 29 (Naval Observa- tory). | 10 57 | -33.5 | 343.9 | +11.5 | | | 53 | |
| | | +5.5 | 22.9 | +13.0 | | | 170 | |
| | | +14.0 | 31.4 | -7.0 | 185 | | | 408 |
| Apr. 30 (Naval Observa- tory). | 10 59 | -20.0 | 344.2 | +11.5 | | | 154 | |
| | | +19.0 | 23.2 | +13.0 | | | 170 | |
| | | +26.5 | 30.7 | -7.0 | 185 | | | 509 |
| Mean daily area for April. | | | | | | | | 434 |

AEROLOGICAL OBSERVATIONS

By RICHMOND T. ZOCH

Free-air temperatures were above normal at all the levels at Broken Arrow, Ellendale, and Royal Center and at some of the levels at Due West and Groesbeck. At Ellendale these positive departures were very large.

Free-air relative humidities were below normal at most levels at all of the stations.

Free-air vapor pressures were mostly above normal at Broken Arrow, Ellendale, and Royal Center and below

normal at Due West and Groesbeck. The vapor pressure departures followed the trend of the temperature departures.

The resultant winds were variable from the surface to the 1,500-meter level. Above this level they were westerly.

Airplane observations made at the naval air station, Seattle, Wash., have been included in Table 2.